



INTEROFFICE CORRESPONDENCE

DATE: October 25, 1994

TO: D. G. Satterwhite, Nuclear Safety Engineering, Bldg. 866, X4028

FROM: S. G. Stiger, Environmental Restoration Program Division, Bldg. 080, X8540 *SG Stiger*

SUBJECT: APPLICABILITY OF THE NUCLEAR FACILITY DESIGNATION PER 10 CFR 830 TO ENVIRONMENTAL RESTORATION ACTIVITIES - SGS-509-94

Ref: A. H. Burlingame ltr, AHB-007-94, to Distribution, Implementation Plan Development for Department of Energy (DOE) Rule 10 CFR 830.120, Quality Assurance Requirements, June 14, 1994

Action: None

DOE Order: 5700.6C

Environmental Restoration Program Division (ERPD) has reviewed the nuclear facility designations to determine what nuclear facilities fall within ERPD's scope. Based on this review, ERPD would like to make the following clarifications to the designation and their responsibility. Currently, ERPD is concerned with three non-reactor nuclear facilities and activities: the 750 Pad, the 904 Pad, and the 903 Pad. The former two areas are actually managed by an organization other than ERPD, Waste Operations, and as a result, routine quality controls are the responsibility of the managing organization. Classification of the latter area, the 903 Pad, as a nuclear facility is probably not appropriate. An evaluation has been done of the 903 Pad and indicating that the non-reactor nuclear facility designation is not appropriate.

To explain our concern, it would be necessary to evaluate other areas using the same rationale given in Attachments 1 & 2. If you were to use these same assumptions, then any three (3) mile by three (3) mile area should be designated as a nuclear facility because of the presence of ambient plutonium background. Even if the criteria is that a facility must be an engineered system (i.e., an asphalt pad) then every nine (9) square miles of road or the equivalent area we sprayed with water to control dust would be a nuclear facility. Using the plutonium inventory criteria, Standley Lake and any three (3) mile by (3) mile area of downtown Denver would probably qualify as a nuclear facility even though they

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meet the free release criteria of DOE Order 5400.5 (and probably 10 CFR 834 when issued).

Clearly, inventory based action levels were not intended to address soil contamination. Attachment 1 indicates that in only one of the three scenarios analyzed, the 903 Pad exceeds the activity threshold level for Pu-239. Attachment 1 also indicates that the 903 Pad does not meet the "significant localized consequence" criteria specified by the order. This criteria is the basis for the standard but involved a scenario that is not applicable to uniform soil contamination. Attachment 2 shows that these threshold values are inappropriate, thus, the 903 Pad is not a nuclear facility under the definition in 10 CFR 830 and does not meet the basis for the criteria in the DOE standard (DOE-STD-1027). Consistent with DOE graded application of the nuclear facility designation, the 903 Pad is not a nuclear facility.

If you have any questions about this determination, please contact Steve Luker at extension 8625.

SW:lmw

Attachments:
As Stated (2)

cc:
K. Bentzen
M.C. Brooks
D. S. Brown
J. E. Hoff
R. S. Luker
ERPD Project File (2)

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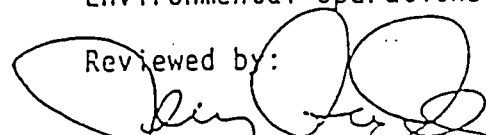
Hazard Category Determination
for
Operable Unit No. 2, 903 Pad
in accordance with
Department of Energy Standard 1027

Prepared by:

 12/14/93

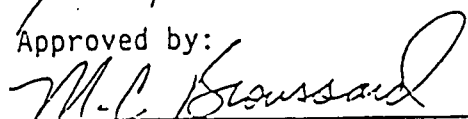
K. D. Anderson
Environmental Operations Management

Reviewed by:

 12/14/93

J. L. Anderson
Radiological Engineering

Approved by:



M. C. Broussard
Environmental Operations Management

Introduction

A hazard categorization evaluation of the Operable Unit No. 2, 903 Pad, asphalt covered area, has been conducted. Based upon this evaluation it has been concluded that 903 Pad is a Hazard Category 3 facility based upon Department of Energy Standard 1027 (DOE-STD-1027), "Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports."

Department of Energy (DOE) Order 5480.23, Nuclear Safety Analysis Reports, requires all contractors to prepare and submit for approval Safety Analysis Reports (SARs) for nuclear facilities. Additionally, DOE Order 5480.22, Technical Safety Requirements (TSR), requires that TSRs be submitted, if required to DOE for approval. As part of an effort to determine which facilities require upgraded SARs and TSRs, a Preliminary Hazard Assessment (PHA) was performed. This evaluation provides the Hazard Category determination of the 903 Pad and supplements the PHA performed for other facilities.

DOE Order 5480.23 defines a nuclear facility as follows:

5.l. Nuclear Facility means reactor and nonreactor nuclear facilities.

The order goes on to detail a nonreactor nuclear facility as:

5.k. Nonreactor Nuclear Facility means those activities or operations that involve radioactive and/or fissionable materials in such a form and quantity that a nuclear hazard potentially exists to the employees or the general public. Included are activities or operation that:

- (1) Produce, process, or store radioactive liquid or solid waste, fissionable materials, or tritium;
- (2) Conduct separations operations;
- (3) Conduct irradiate materials inspection, fuel fabrication, decontamination, or recovery operations;
- (4) Conduct fuel enrichment operations; or
- (5) Perform environmental restoration or waste management activities involving radioactive materials.

The basis for inclusion of the 903 Pad as a nonreactor nuclear facility is based solely upon Section 5.k.(5), since no other activity or process would require its inclusion. However, in order to conduct an evaluation for the SAR and related

TSRs, a hazard category must be assigned to the facility. This is accomplished by applying DOE-STD-1027. By calculating the total activity of radioisotopes of concern, a hazard category can be set.

Site History and Description

The 903 Pad was utilized from 1955 to June 1968 as a storage area for drums containing radioactively contaminated, used machining oils. 33-gallon and 50-gallon drums were originally stored at the site, some of which corroded and leaked. Many of the drums contained oils and solvents contaminated with Plutonium (Pu) while others were contaminated with Uranium. Most of the drums contained lathe coolant consisting of mineral oil (i.e. petroleum distillate oil) and carbon tetrachloride in varying proportions. However, an unknown number of drums contained hydraulic oils and other chemical contaminants. Ethanolamine was also added to drums placed at the site after 1959 to reduce the container corrosion rate. All drums were removed by 1968.

The chronology of the drum removal and subsequent clean-up efforts are described by Freiberg (1970)¹. The process included field transfer, prefiltering and treatment of the oils.

In 1968, site grading activities were conducted at the 903 Drum Storage Site for the installation of the asphalt cover. Contaminated soils and rocks were removed from within the fenced area, resulting in a total of 33 drums being removed in May, 1969. Two courses (6 inches each) of clean fill were then placed over the storage area, with an application of soil sterilant and asphalt prime. This was completed by September, 1969². The asphalt cover was completed in October 1969.

The asphalt cover is rectangular and oriented north-south (370 feet) and east-west (395 feet). The slope of the pad is slightly to the northeast at a drop of 1 foot per 100 feet. The asphalt cover is approximately 3.2 inches thick and is underlain by 6 inches of loose gravel and 3.2 inches of fill soil (in addition to the two courses of material). This provides for a total thickness of 24 inches (2 feet) overlay below the cover.

The 903 Pad has been included in Operable Unit No. 2 and is being addressed in compliance with the Comprehensive Environmental Restoration and Conservation Liability Act (CERCLA) and the Resource Conservation and Recovery Act (RCRA). This is accomplished under the Interagency Agreement (IAG) between the Department of Energy (DOE), the Environmental Protection Agency (EPA), and the Colorado Department of Health (CDH).

¹K. J. Freiberg ltr. to E. A. Putzier, 903 Drum Storage Area, DOW Chemical Company, Rocky Flats Division, April 14, 1970.

²Final Phase II RFI/RI Work Plan (Alluvial) - 903 Pad, Mound, and East Trenches Area, Rocky Flats Plant, Golden, Colorado, Revision 1, February 1991.

Safety Documentation/Safety Assurance

The 903 Pad was considered when the Rocky Flats Plant Site Final Environmental Impact Statement was finalized in 1980. The maximum credible accident scenario involving aircraft crashes evaluated a radioactive release from the 903 Pad site.

Remediation of the 903 Pad is addressed in the Subsurface Interim Measures/Interim Remedial Action Plan, Environmental Assessment and Decision Document, Operable Unit No. 2 (DOE EA-0625, September 10, 1992).

Work activities within Operable Unit No. 2 Individual Hazardous Substance Sites (IHSSs) must be conducted under a Site Specific/Project Specific Health and Safety Plan (HASP). This requirement is driven by the Occupational Safety and Health Administration (OSHA) Title 29 Code of Federal Regulations (CFR) 1910.120, Hazardous Waste Operations and Emergency Response. This details operations and health and safety requirements that must be programmatically implemented for hazardous waste site operations. All personnel are required to comply with requirements as stipulated in the HASPs.

Activities that occur within the 903 Pad area are controlled by Remediation Programs Management and Environmental Operations Management. This is accomplished by use of the Integrated Work Control Program (IWCP) Process for new construction activities or those which do not have approved procedures. All other work is conducted according to Standard Operating Procedures (SOPs), Work Plans, and/or Field Sampling Plans.

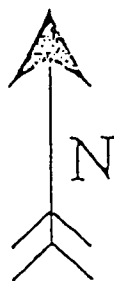
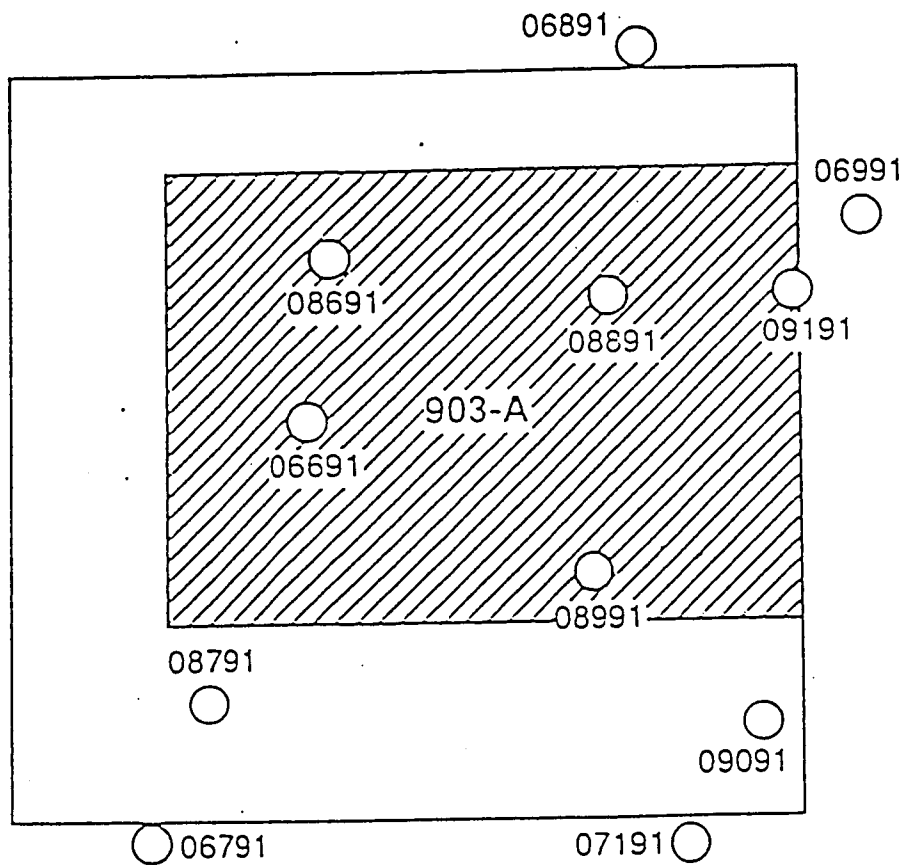
Safety Analysis

The 903 Pad was not originally classified as a high or moderate hazard facility per DOE Order AL 5481.1a, therefore not requiring a separate Safety Analysis Report (SAR) at the time (ie., was assumed to be either a low hazard facility, or exempt as a "common, routine hazard that the public has been exposed to and/or accepted"). It was also not originally classified as a nuclear facility per DOE Order 5480.5.

The potential for nuclear hazards as related to the 903 Pad must be determined prior to a decision made as to the applicability of DOE Order 5480.23. This will be done by identify the potential for nuclear hazards based upon site inventory of radioisotopes of concern.

The primary activity presently conducted at the 903 Pad is sampling of groundwater monitoring wells. Previously, geotechnical investigation which included drilling through the asphalt cover were conducted as part of the RFI/RI field activities.

OPERABLE UNIT NO. 2
PHASE II RFI/RI REPORT
October 1993
903 Pad Asphalt Cover



100 Feet

Method

An estimate of the total activity of identified radioisotopes Plutonium-239,240 (Pu-239,240) and Americium-241 (Am-241) below the 903 Pad asphalt cover, has been completed. Three methods were selected to perform the calculation for source quantity present. Data for the calculations were obtained from the Operable Unit No. 2 Phase II RFI/RI Report (Appendix A). The 903 Pad asphalt cover was separated in two sites, 903-A and 903-B (Figure 1), based upon the distribution of sample activity concentrations. The methods are 1) Use of maximum detected activity concentration for a six foot depth, 2) mean concentration for population for 6 foot intervals up to 20 feet, 903-A and 903-B, and 3) performing a regression analysis of the data for 903-A and 903-B and calculating subsequent total activity.

Calculation 1 - Maximum Concentration

A maximum activity concentration for Pu-239,240 and Am-241 was selected from sample boreholes below and immediately adjacent to the asphalt cover. The activity is applied to a six foot depth.

$$V = \text{soil volume} = 370' \times 395' \times 6' = 8.769E5 \text{ ft}^3$$

$$\rho = \text{soil density} = 1.8 \text{ mg/cm}^3$$

$$A = \text{maximum activity concentration, pCi/g} = \begin{array}{l} 68 \text{ pCi/g : Pu} \\ 25 \text{ pCi/g : Am-241} \end{array}$$

$$A_t = \text{Total activity, Ci} = A \times \rho \times V$$

Calculation 1A: Pu-239,240:

$$\begin{aligned} A_t &= (68 \text{ pCi/g})(1.8 \text{ g/cm}^3)(1 \text{ cm}^3/3.53E-5 \text{ ft}^3)(8.769E5 \text{ ft}^3) \\ &= 3.041E12 \text{ pCi} \\ &= 3.04 \text{ Ci.} \end{aligned}$$

This quantity is less than the total activity of 33.14 Ci, Category 3 for Pu-238,239,241, DOE-STD-1027. However, it exceeds the Category 3 threshold limit of 0.52 Ci for Pu-239.

Calculation 1B: Am-241

$$\begin{aligned} A_t &= (25 \text{ pCi/g})(1.8 \text{ g/cm}^3)(1 \text{ cm}^3/3.53E-5 \text{ ft}^3)(8.769E5 \text{ ft}^3) \\ &= 1.118E12 \text{ pCi} \\ &= 1.118 \text{ Ci} \end{aligned}$$

This quantity is greater than the Hazard Category 3 threshold total activity of 0.52 Ci for Am-241.

Calculation 2 - Mean Concentration

Mean concentrations were calculated for area 903-A and 903-B, for depth intervals of 2-8 ft, 8-14 ft, and 14-20 ft. The mean concentration and the associated standard deviation was determined using the Lotus 1-2-3 Release 3 computer software (Appendix B, C, D, and E). Total activity is the summed value of both sites (Table 1 and 2).

Table 1 Operable Unit No. 2, 903 Pad asphalt cover. Calculated mean activity concentration values for Pu-239,240.

Site	Depth (ft)	Mean Conc. (pCi/g)	A _r (Ci)
903-A	2	31.818	0.790
903-A	8	4.525	0.110
903-A	14	1.004	0.024
903-B	2	0.550	0.011
903-B	8	1.014	0.021
903-B	14	0.036	7.36E-4
		Total	0.957

Table 2 Operable Unit No. 2, 903 Pad asphalt cover. Calculated mean activity concentration values for Am-241.

Site	Depth (ft)	Mean Conc. (pCi/g)	A _r (Ci)
903-A	2	6.299	0.0153
903-A	8	0.350	8.498E-3
903-A	14	0.124	3.011E-3
903-B	2	0.094	1.921E-3
903-B	8	0.112	2.289E-3
903-B	14	0.140	2.861E-3
		Total	0.172

The total activity of 0.957 Ci for Pu-239,240, is less than category 3 Pu-238,239,241 and greater than that for Pu-239.

The total activity of 0.172 for Am-241 is less than that for Category 3.

Calculation 3 - Linear Regression Analysis

By applying linear regression analysis (LRA), the independent and dependant variables of the 903-A and 903-B sites provide an indication of the average rate of change of contamination with respect to depth (Appendix B, C, D, and E). By relating the independent x-variable (depth) to the dependant y variable (activity concentration), regression coefficients were determined,

$$\beta_0 = \text{constant}$$

$$\beta_1 = \text{slope}$$

these were then applied to the linear function,

$$\mu(x) = \beta_0 + \beta_1 x.$$

By applying the linear function to depths of 2 to 20 feet, activity concentrations as dependant upon depth were calculated (Table 3). Curves of activity concentrations with respect to depth were generated for each site (Figure 2, 3, 4, and 5). This indicates that for Plutonium, the contamination decreased with depth. However, the curve of 903-B site data, Am-241, indicated that the contamination increased with depth. This is attributed to the variation of the population.

Table 3 Operable Unit No. 2, 903 Pad asphalt cover. Total activity of Pu-239,240 and Am-241 as determined separately by Linear Regression Analysis (LRA) for the 903-A and 903-B sites.

Site	LRA A(Ci) Pu-239,240,241	LRA A(Ci) Am-241
903-A	0.738	0.047
903-B	0.037	0.0048
Total	0.775	0.052

The total activity of 0.775 Ci of Pu-239,240,241 is less than Category 3 for Pu-239,241, and greater then Pu-239.

The total activity of 0.052 Ci for Am-241 is less than that for Category 3.

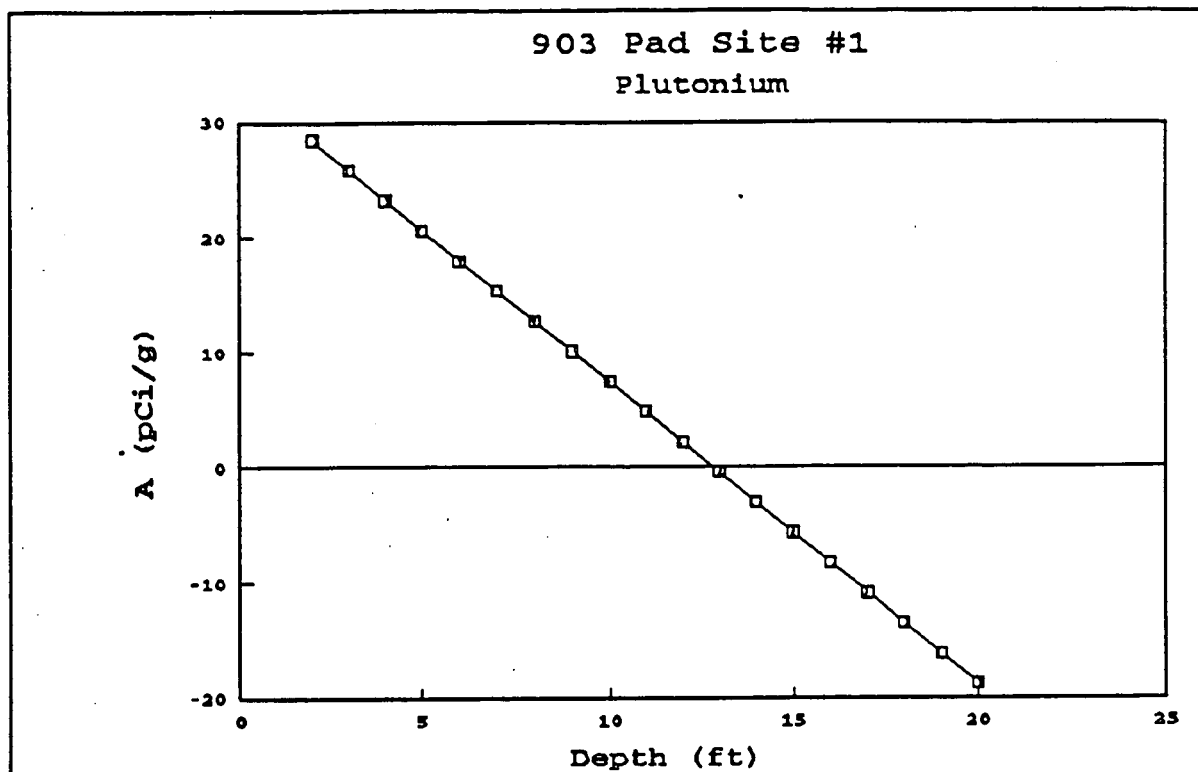


Figure 2

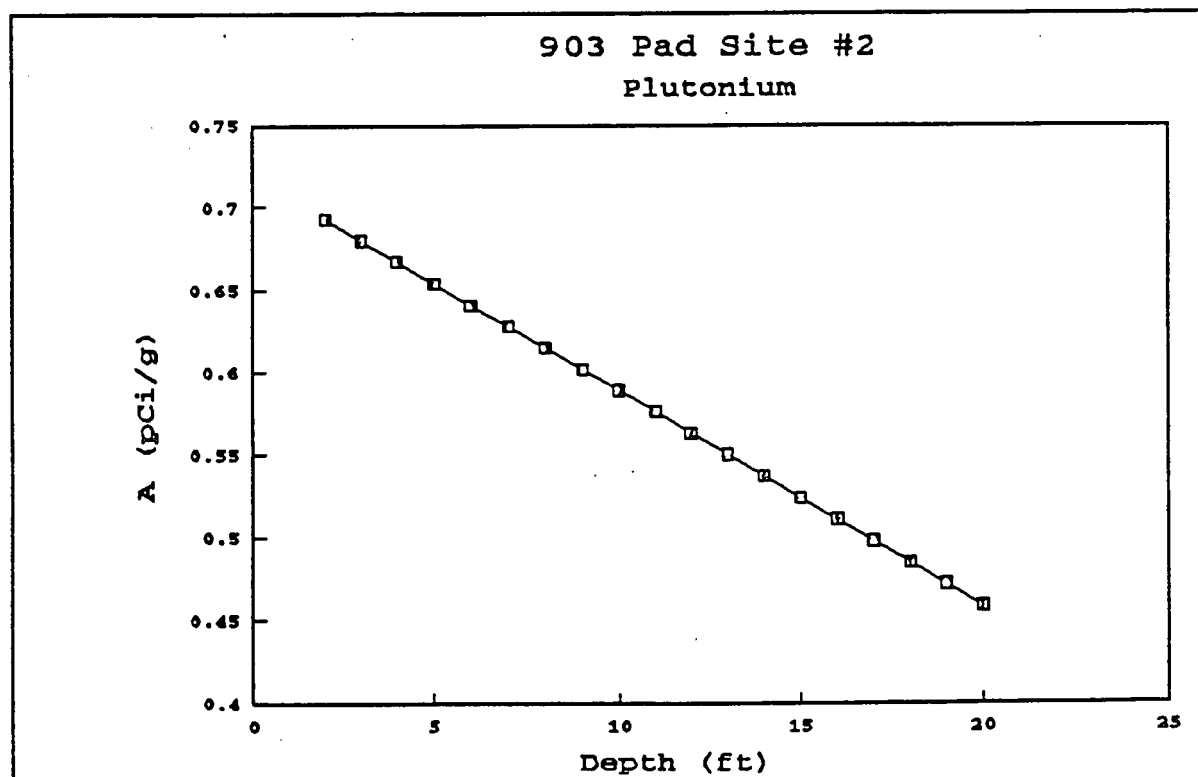


Figure 3

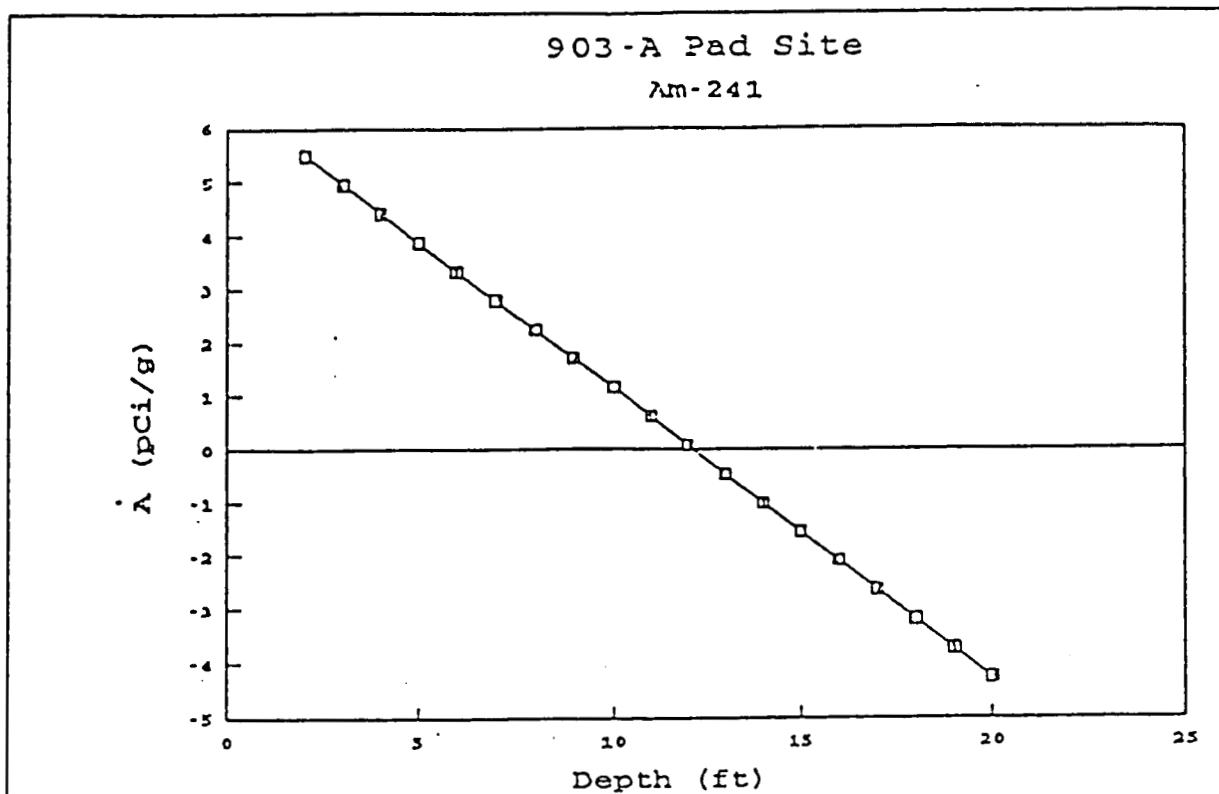


Figure 4

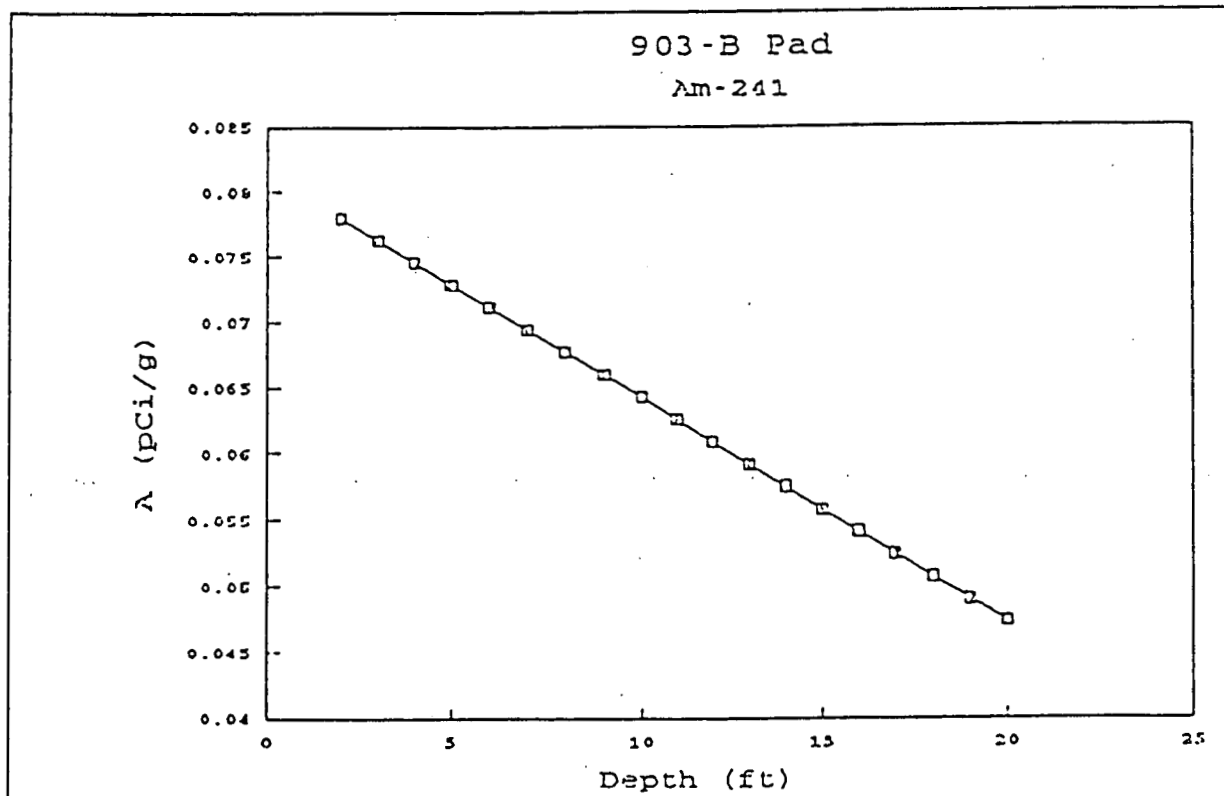


Figure 5

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Conclusion and Recommendations

Based upon the calculations performed, the estimated inventory of Am-241 does not exceed the limit for a Nuclear Hazard Category 3 Facility. This is based upon the results of Calculations 2 and 3, which provides for a conservative and reasonable approach to soil contamination inventory for Am-241.

However, the estimated soil contamination inventory for Pu-239,240 does exceed the Category 3 level for Pu-239. It does not exceed the total level for Pu-238,239,241. The three calculations performed would support this assumption. If the assumption was made that detected Plutonium activity is due to Pu-239 exclusively, it would be appropriate to assume that a SAR would be required for the 903 Pad. This is based solely upon the DOE-STD-1027, Attachment 1.

As discussed previously, environmental remediation or waste management activities involving radioactive materials may be considered Nonreactor Nuclear Facilities, as per DOE Order 5480.23. This would infer that environmental remediation activities could be covered by a single SAR. Specific references throughout the Order are made to engineered safety features, processes, and structural components that provide for mitigation of potential and known hazards. The only physical component of the 903 Pad which could be considered either an engineered safety feature or a form of containment is the asphalt cover and associated fill material. The risk as defined by the Order, is "the quantitative or quantitative expression of possible loss that considers both the probability that a hazard will cause harm and the consequences of that event" and a loss must result in "significant localized consequences". A loss is not characteristic of the 903 Pad. A risk assessment would be based upon the impact of intact contaminants and those released from the site by natural process to local inhabitants.

DOE-STD-1027, Table 3.1 defines Category 3 in that the "Hazard analysis shows the potential for only significant localized consequences," with an interpretation that "Facilities with quantities of hazardous radioactive materials which meet or exceed Attachment 1 values". As mentioned references to facilities include physical and engineered systems that are involved in operations, processes, or activities. A detailed discussion of Hazard Category 3 in DOE-STD-1027 states that "...values for radionuclides represent levels of material which, if released, would produce less than 10 rem doses at 30 meters based on 24 hour exposure". If the complete inventory of contamination present below the 903 Pad was released, the potential for such a dose does exist. The probability of such an event is unlikely, in that a total volume of $2.923E6 \text{ ft}^3$ would not be released in 24 hours, outside of a catastrophic event. A discussion of the calculation of Category 3 Radiological Thresholds shows that the limit is based upon an exposure "...for one day for inhalation and direct exposure, but that persons are exposed for longer periods through the ingestion pathway in order to account for the slow movement of radionuclides in ground water." Thus, an inference is made to environmental contamination and exposure.

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It is stressed that the form of the nuclear material is not clear in any of the Orders or Standards pertaining to Safety Analysis Reviews. Fissionable material is inclusive to the "forms". DOE Order 5480.5 defines fissionable materials as nuclides capable of sustaining a neutron induced fission chain reaction. The contamination present at the 903 Pad is not capable of sustaining a fission reaction due to its non-critical mass state. DOE Order 5480.23.5.(i) includes hazardous material, but explicitly excludes oils. Thus, the form as required for a Nonreactor Nuclear Facility does not seem to coincide with the 903 Pad contaminants.

It is therefore recommended that the 903 Pad and such sites which may involve radioactive materials be placed on the Site SAR. This is the appropriate document to provide for a hazard assessment of the potential impacts to the worker, public, and the environment resulting from environmental restoration activities. Individual SARs for each site which exhibits potential contamination inventories which fall within Category 3 Radiological Thresholds does not meet the intent of DOE Order 5480.23.

APPENDIX A

Operable Unit No. 2, Phase II RFI/RI Report, October, 1993. Borehole data from subsurface investigations, 903 Pad, for Pu-239,240 and Americium-241.

Borehole Location	Depth (ft)	A (pCi/g) Pu-239,240	A (pCi/g) Am-241
8691	2	11.000	1.800
6691	2	68.000	7.200
8791	2	0.035	0.270
6791	2	0.083	0.120
8991	2	9.910	2.120
7191	2	0.100	0.039
9091	2	3.000	0.290
8891	2	27.000	0.880
6891	2	0.020	
6991	2	0.061	0.018
9191	2	25.000	25.000
9191	2	50.000	6.800
7091	2	0.550	0.025
8691	8	0.070	0.013
6691	8	5.600	0.820
8791	8	0.037	0.011
6791	8	0.056	0.014
8991	8	0.757	0.254
7191	8	0.048	0.013
9091	8	0.030	0.021
8891	8	14.000	0.470
9191	8	2.200	0.520
7091	8	4.900	0.410

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APPENDIX A

Operable Unit No. 2, Phase II RFI/RI Report, October, 1993. Borehole data from subsurface investigations, 903 Pad, for Pu-239,240 and Americium-241, continued.

Borehole Location	Depth (ft)	A (pCi/g) Pu-239,240	A (pCi/g) Am-241
6591	14	0.032	0.140
8691	14	2.300	0.160
6691	14	0.680	0.040
8991	14	0.367	0.200
8991	14	0.476	
7191	14	0.041	
8891	14	1.500	0.200
9191	14	0.063	0.020

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APPENDIX B

Operable Unit No. 2, Phase II RFI/RI Report, October, 1993. Pu-239,240 subsurface data for 903-A Site. LRA derived activity concentration (pCi/g), LRA total activity (Ci), and Regression Output.

Borehole Location	Depth (ft)	A(pCi/g)	LRA Depth (ft)	LRA A(pCi/g)	LRA A(Ci)
8691	2	11.000	2	28.422	0.115
6691	2	68.000	3	25.798	0.104
8991	2	9.910	4	23.173	0.094
8891	2	27.000	5	20.549	0.083
9191	2	25.000	6	17.925	0.073
9191	2	50.000	7	15.300	0.062
8691	8	0.070	8	12.676	0.051
6691	8	5.600	9	10.051	0.041
8991	8	0.757	10	7.427	0.030
8891	8	14.000	11	4.802	0.019
9191	8	2.200	12	2.178	0.009
8691	14	2.300	13	-0.447	-0.002
6691	14	0.680	14	-3.071	-0.012
8991	14	0.476	15	-5.696	-0.023
8891	14	1.500	16	-8.320	-0.034
9191	14	0.063	17	-10.945	-0.044
			18	-13.569	-0.055
			19	-16.194	-0.066
			20	-18.818	-0.076
				Total A(Ci)	0.738

Regression Output:

Constant	33.671
Std Err of Y Est	15.214
R Squared	0.456
No. of Observations	16
Degrees of Freedom	14
X Coefficient(s)	-2.624
Std Err of Coef.	0.767

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APPENDIX C

Operable Unit No. 2, Phase II RFI/RI Report, October 1993. Pu-239,240 subsurface data for 903-B site. LRA derived activity concentrations (pCi/g), LRA total activity (Ci), and Regression Output.

Borehole Location	Depth (ft)	A(pCi/g)	LRA Depth (ft)	LRA A(pCi/g)	LRA A(Ci)
8791	2	0.035	2	0.693	0.002
6791	2	0.083	3	0.680	0.002
7191	2	0.100	4	0.667	0.002
9091	2	3.000	5	0.654	0.002
6891	2	0.020	6	0.640	0.002
6991	2	0.061	7	0.627	0.002
7091	2	0.550	8	0.614	0.002
8791	8	0.037	9	0.601	0.002
6791	8	0.056	10	0.588	0.002
7191	8	0.048	11	0.575	0.002
9091	8	0.030	12	0.562	0.002
7091	8	4.900	13	0.549	0.002
6591	14	0.032	14	0.536	0.002
7191	14	0.041	15	0.523	0.002
			16	0.510	0.002
			17	0.497	0.002
			18	0.484	0.002
			19	0.471	0.002
			20	0.458	0.002
				Total A(Ci)	0.037

Regression Output:

Constant	0.719
Std Err of Y Est	1.515
R Squared	0.002
No. of Observations	14
Degrees of Freedom	12
X Coefficient(s)	-0.013
Std Err of Coef.	0.094

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APPENDIX D

Operable Unit No. 2, Phase II RFI/RI Report, October, 1993. Am-241 subsurface data for 903-A site. LRA derived activity concentration (pCi/g), LRA total activity (Ci), and Regression Output.

Borehole Location	Depth (ft)	A (pCi/g)	LRA Depth (ft)	LRA A(pCi/g)	LRA A(Ci)
8691	2	1.800	2	5.489	0.022
6691	2	7.200	3	4.947	0.020
8991	2	2.120	4	4.406	0.018
9091	2	0.290	5	3.864	0.016
8891	2	0.880	6	3.323	0.013
9191	2	25.000	7	2.781	0.011
9191	2	6.800	8	2.239	0.009
8691	8	0.013	9	1.698	0.007
6691	8	0.820	10	1.156	0.005
8991	8	0.254	11	0.615	0.002
9091	8	0.021	12	0.073	0.000
8891	8	0.470	13	-0.468	-0.002
9191	8	0.520	14	-1.010	-0.004
8691	14	0.160	15	-1.551	-0.006
6691	14	0.040	16	-2.093	-0.008
8991	14	0.200	17	-2.634	-0.011
8891	14	0.200	18	-3.176	-0.013
9191	14	0.020	19	-3.718	-0.015
			20	-4.259	-0.017
				Total A(Ci)	0.047

Regression Output:

Constant	6.572
Std Err of Y Est	5.517
R Squared	0.203
No. of Observations	18
Degrees of Freedom	16
X Coefficient(s)	-0.542
Std Err of Coef.	0.268

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APPENDIX E

Operable Unit No. 2, Phase II RFI/RI Report, October, 1993. Am-241 subsurface data for 903-B site. LRA derived activity concentration (pCi/g), LRA total activity (Ci), and Regression Output.

Borehole Location	Depth (ft)	A(pCi/g)	LRA Depth (ft)	LRA A (pCi/g)	LRA A (Ci)
8791	2	0.270	2	0.078	0.000
6791	2	0.120	3	0.076	0.000
7191	2	0.039	4	0.074	0.000
6991	2	0.018	5	0.073	0.000
7091	2	0.025	6	0.071	0.000
8791	8	0.011	7	0.069	0.000
6791	8	0.014	8	0.068	0.000
7191	8	0.013	9	0.066	0.000
6591	14	0.140	10	0.064	0.000
			11	0.063	0.000
			12	0.061	0.000
			13	0.059	0.000
			14	0.057	0.000
			15	0.056	0.000
			16	0.054	0.000
			17	0.052	0.000
			18	0.051	0.000
			19	0.049	0.000
			20	0.047	0.000
				Total A(Ci)	0.004811

Regression Output:

Constant 0.081
 Std Err of Y Est 0.094
 R Squared 0.007
 No. of Observations 9
 Degrees of Freedom 7
 X Coefficient(s) -0.002
 Std Err of Coef. 0.008

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Evaluation of Hazard Class Threshold Quantities Defined in DOE-STD-1027 Relative to Ambient Background Soil Contamination Limits

Statement of Consideration

This appendix evaluates how much land surface would be required to exceed the Hazard Category 3 Threshold quantity for Pu-239 and Am-241 in *DOE Standard Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*. If these sites were classified as DOE Non-Reactor Nuclear Facilities based on these threshold quantities additional requirements and controls would be applied to these locations. Thus it is important to assess the applicability of these threshold quantities to an open area with dispersed soil contamination. As a first step in this evaluation it appears appropriate to first assess how ambient background relates to these threshold quantities.

Calculation

Based on the U.S. DOE 1993 Background Geochemical Characterization Report, the ambient Pu/Am background in the Denver/RFETS area is summarized in Table 1 below. Since transuranics typically remain in the first 30 cm of soil, the source term used is based on the contents in this soil layer. The average source term for this 30 cm layer of soil is also included in Table 1.

TABLE 1
Ambient Background Concentrations in Soil

Soil		Radionuclide Concentration in Soil (pCi/g)	
Type	Soil Depth (cm)	Pu-239	Am-241
Surficial	<15	0.027	0.062
Vadose	>15	0.01	0.02
Source Term	30	0.014	0.032

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Based on the threshold quantities in Attachment 1 of the DOE Standard (DOE-STD-1027-92) the Hazard Category 3 threshold quantities are summarized in Table 2.

TABLE 2
Hazard Category 3 Threshold Quantities

Radionuclide	Activity (Ci)
Pu-239	0.52
Am-241	0.52

This calculation assumes a soil density of 1.65 g/cm³ to convert soil concentrations in pCi/g to a volume based concentration in pCi/cm³ in the calculation below.

Soil area is:

$$A(m^2) = V(cm^3) \cdot 10^{-6} (m^3/cm^3) / D(m)$$

Relating the area to the mass of the soil:

$$V(cm^3) = M(g) / \rho_{soil}(g/cm^3)$$

$$A(m^2) = M(g) \cdot 10^{-6} (m^3/cm^3) / [D(m) \cdot \rho_{soil}(g/cm^3)]$$

Using the ambient background concentration to relate the soil area to the soil activity concentration:

$$M(g) = Act(Ci) \cdot 10^{12} (pCi/Ci) / Cb(pCi/g)$$

$$A(m^2) = Act(Ci) \cdot 10^6 (pCi \cdot m^3/cm^3 / Ci) / [D(m) \cdot \rho_{soil}(g/cm^3) \cdot Cb(pCi/g)]$$

Where:

A(m²) is the surface of the soil volume.

V(cm³) is the soil volume.

D(m) is the depth of the soil volume (i.e., 0.3 m).

M(g) is the mass of the soil volume.

$\rho_{soil}(g/cm^3)$ is the density of the soil (i.e., 1.65g/cm³).

Act(Ci) is the total activity in the soil volume.

Cb(pCi/g) is the average activity in the soil volume (i.e., see Table 1).

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By setting the value of soil volume activity content (i.e., Act) to the threshold quantities (i.e., Table 2) for Hazard Category 3, we can calculate the area of a soil volume 0.3 m (30 cm) deep that would contain this total activity.

For Pu-239 only:

$$A(m^2) = 0.52(Ci) \cdot 10^6 (pCi \cdot m^3/cm^3/Ci) / [0.3(m) \cdot 1.65(g/cm^3) \cdot .032(pCi/g)]$$

$$A(m^2) \approx 3.3 \times 10^7$$

$$X(m) = [A(m^2)]^{0.5}$$

$$X(m) = 5730 \text{ m} \approx 6 \text{ km}$$

For Am-241 only:

$$A(m^2) = 0.52(Ci) \cdot 10^6 (pCi \cdot m^3/cm^3/Ci) / [0.3(m) \cdot 1.65(g/cm^3) \cdot .014(pCi/g)]$$

$$A(m^2) \approx 7.5 \times 10^7$$

$$X(m) = [A(m^2)]^{0.5}$$

$$X(m) = 8660 \text{ m} \approx 9 \text{ km}$$

For Am-241 and Pu-239:

$$A(m^2) = 0.52(Ci) \cdot 10^6 (pCi \cdot m^3/cm^3/Ci) / [0.3(m) \cdot 1.65(g/cm^3) \cdot .046(pCi/g)]$$

$$A(m^2) \approx 2.3 \times 10^7$$

$$X(m) = [A(m^2)]^{0.5}$$

$$X(m) = 4780 \text{ m} \approx 5 \text{ km}$$

Conclusion

Based on this data it would appear that any rectangular area near Denver about three (3) miles by three (3) miles (5km by 5km) would be a DOE Non-Reactor Nuclear Facility. It would appear the appropriate method for designation of a Non-Reactor Nuclear Facility related to soil contamination would involve a soil concentration number. This number should have equivalent level of risk and could be determined using the method established in DOE 5400.5, Chapter IV or in 10 CFR 834 (once issued) using the action level criteria that is the basis for DOE-STD-1027.

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